Letter to the Editor

Differences in Pandemic-Related Factors Associated with Alcohol and Substance Use among Korean Adolescents: Nationwide Representative Study*

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The coronavirus disease 2019 (COVID-19) pandemic has raised concerns about the mental health and social well-being of youth, including its potential to increase or exacerbate substance use behaviors[1]. Among adolescents, the COVID-19 pandemic has resulted in limited face-to-face school contact and thus missed milestones in preventing alcohol and substance use. Moreover, it has increased family stressors, and the loss of typical resilience-promoting activities (e.g., physical activity) has disrupted a crucial development period[1,2]. However, despite the significance of the pandemic's effects on daily life, only a few studies have been conducted on substance use in youth during the COVID-19 pandemic. Given this background, this study aimed to determine the changes in alcohol and substance use according to familial, social, and individual risk factors among Korean adolescents during the COVID-19 pandemic[3].

We obtained data for the period 2005–2021 from the Korea Youth Risk Behavior Web-based Survey (KYRBS), an annual survey conducted by the Korea Disease Control and Prevention Agency (KDCA) on government policies[4]. The target population comprised middle and high school students (aged between 12–18 years). The sampling process included population stratification, sample allocation, and sampling stages. The population was divided into 117 strata based on the school type (middle, general, or specialist high school) and 39 regional groups (size, location, geographical accessibility, number of schools and population, living environment, current smoking rate, and drinking rate) as stratification variables. For sample allocation, the sample size was divided into 400 junior high schools and 400 high schools, with a priority allocation of five each to 17 cities and provinces to ensure that the population composition ratio was equal in the entire population and in the sample. A stratification method was used for sampling; the primary sampling unit was the school (selected by the permanent random number sampling method for each stratum), and the secondary sampling unit was the class (one class was randomly selected for each grade from the selected sample schools). The sample size for each year

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varied, ranging from approximately 53,445 to 73,473 participants. Participants voluntarily participated in a web-based survey at their schools (average response rate: 95%)[2,4]. The study protocol was endorsed by Kyung Hee University (KHUH 2022-06-042) and the KDCA, who provided written informed consent.

This study was conducted to elucidate the risk factors for alcohol and substance use over the years and changes that occurred before and during the COVID-19 pandemic. Adolescent participants were asked to report the number of days they had consumed alcohol within the past 30 days, with response options including none, 1–2 d, 3–5 d, 6–9 d, 10–19 d, 20–29 d, and every day. According to their response, participants were categorized as either nondrinkers or current drinkers. Current drinkers were defined as those who had consumed alcohol for 1–30 days within the past 30 days. Additionally, those who drank alcohol daily were classified as daily drinkers.

The question "Have you ever taken substances often used non-medically (e.g., inhalants, glue, stimulants, cannabis, amphetamines, marijuana, codeine, neuroleptics) for mood elevation, hallucinogenic experience, or extreme dieting?" was used to assess lifetime substance use. Answering "Yes" to this question required participants to select one drug from a list of 33 commonly used substances divided into nine categories (for example: inhalants, e.g., butane gas, bond, thinner, varnish, lighter gas; stimulants, e.g., caffeine pills; tranquilizers, e.g., Valium, Ativan, Xanax; a large dose of antitussive, e.g., Luminar, Lubiking, Soma, Zinolta; diet pills, e.g., Lasix, Prion; marijuana; Hiropon; other hallucinogens, e.g., ketamine, LSD, ecstasy, 5-MeO-DiPT, kratom, crystal methamphetamine; and opioid drugs, e.g., opiates, morphine, Demerol, Nubaine; cocaine).

Due to cultural and legal prohibitions on all substances in Korea, it is difficult to identify adolescents who continuously use substances. Therefore, this study focused on participants' experiences with substance use throughout their lifetimes[5].

The variables included age (continuous; individual-associated factors), grade (7^{th}–9^{th} and 10^{th}–12^{th} grade; social-associated factors), sex (individual-associated factors), body mass index (BMI) (continuous; individual-associated factors), residential areas (rural and urban; social-associated factors), current smoking habits (individual-associated factors), depressive symptoms (individual-associated factors), highest educational level of parents (high school or lower, college or higher, and unknown; familial-associated factors), perceived economic status (high, middle-high, middle, middle-low, and low; familial-associated factors), and perceived academic performance in the past 12 months (high, middle-high, middle, middle-low, and low; individual-associated factors).

Qualitative data were presented as percentages or proportions. Changes in risk factors between the pre-COVID-19 pandemic (2005–2019) and COVID-19 pandemic (2020–2021) periods were compared using the chi-square test for categorical variables and the *t*-test for continuous variables[6]. Furthermore, we confirmed the linearity assumption of BMI using the Box-Tidwell test, the normality assumption using the Kolmogorov-Smirnov test, and the homogeneity of variances assumption using Levene's test (all *P* values > 0.05).

Crude and adjusted odds ratios (*OR*) with 95% confidence intervals (*CI*) in multivariate and univariate regression model analyses were used to compare the estimates of each associated factor before and during the pandemic. The *OR* was calculated for each variable and estimated for a 1 unit increase in BMI (1 kg/m^2). Additionally, this study employed the ratio of odds ratio (*ROR*) as a metric to assess the interaction between the pre- and during-pandemic conditions, utilizing Cox and Snell's methodology[7,8]. Statistical analyses were performed using SPSS software (version 22.0; IBM, Armonk, NY, USA). All tests were two-sided and were considered statistically significant when the *P* value was less than 0.05.

A total of 1,109,776 adolescents were included in the KYRBS-related current alcohol use analysis from 2005 to 2021 (Table 1). A total of 1,043,708 adolescents were included in the substance use analysis between 2005 and 2021 (Table 2). Data on substance use in 2015 were omitted from the KYRBS; therefore, the 2015 substance use data were not included in the study. For the pre-COVID-19 pandemic, the proportion of male participants using alcohol was 57.3% and the mean ± SD age was 15.77 ± 1.57 years. For substance use, 63.8% were male and their mean ± SD age was 14.87 ± 1.77 years old. During the pandemic, the proportion of male participants using alcohol was 58.8% and the mean ± SD age was 16.04 ± 1.60 years old. For substance use, 58.1% were male participants and their mean ± SD age was 15.34 ± 1.73 years old.

The study revealed that high school students, males, current smokers, those who experienced depression, individuals with parents having a high

Table 1. Baseline characteristics for current alcohol use among Korean youth in KYRBS, 2005–2021

Variables	Pre-COVID19 pandemic				COVID-19 pandemic			
	Overall (*n* = 1,002,797), *n* (%) or mean ± SD	No (*n* = 802,340), *N* (%) or mean ± SD	Yes (*n* = 200,457), *n* (%) or mean ± SD	*P* value	Overall (*n* = 106,979) *N* (%) or mean ± SD	No (*n* = 95,757), *n* (%) or mean ± SD	Yes (*n* = 11,222), *n* (%) or mean ± SD	*P* value
Age, years	14.98 ± 1.74	**14.78 ± 1.72**	**15.77 ± 1.57**	**< 0.001**	15.09 ± 1.75	**14.98 ± 1.73**	**16.04 ± 1.60**	**< 0.001**
Grade				**< 0.001**				**< 0.001**
7^{th}–9^{th} grade (middle school)	516,321 (51.5)	**456,602 (56.9)**	**59,719 (29.8)**		57,611 (53.9)	**54,352 (56.8)**	**3,259 (29.0)**	
10^{th}–12^{th} grade (high school)	486,476 (48.5)	**345,738 (43.1)**	**140,738 (70.2)**		49,368 (46.1)	**41,405 (43.2)**	**7,963 (71.0)**	
Sex				**< 0.001**				**< 0.001**
Male	516,595 (51.5)	**571,466 (71.2)**	**114,795 (57.3)**		55,460 (51.8)	**48,857 (51.0)**	**6,603 (58.8)**	
Female	486,202 (48.5)	**230,874 (28.8)**	**85,662 (42.7)**		51,519 (48.2)	**46,900 (49.0)**	**4,619 (41.2)**	
BMI, kg/m^2	20.73 ± 3.14	**20.66 ± 3.16**	**20.99 ± 3.05**	**< 0.001**	21.57 ± 3.75	**21.50 ± 3.74**	**21.57 ± 3.75**	**< 0.001**
Residence				**< 0.001**				**< 0.001**
Rural	468,098 (46.7)	**378,517 (47.2)**	**89,581 (44.7)**		46,398 (43.4)	**41,962 (43.8)**	**4,436 (39.5)**	
Urban	534,699 (53.3)	**423,823 (52.8)**	**110,876 (55.3)**		60,581 (56.6)	**53,795 (56.2)**	**6,786 (60.5)**	
Currently smoking	99,169 (9.9)	**30,145 (3.8)**	**69,024 (34.4)**	**< 0.001**	4,624 (4.3)	**1,615 (1.7)**	**3,009 (26.8)**	**< 0.001**
Substance use	9,559 (1.0)	**5,349 (0.7)**	**4,210 (2.1)**	**< 0.001**	723 (0.7)	**542 (0.6)**	**181 (1.6)**	**< 0.001**
Depression	319,834 (31.9)	**230,874 (28.8)**	**88,960 (44.4)**	**< 0.001**	27,622 (25.8)	**23,150 (24.2)**	**4,472 (39.9)**	**< 0.001**
Highest educational level of parents				**< 0.001**				**< 0.001**
High school or lower	498,237 (49.7)	**378,825 (47.2)**	**119,412 (59.6)**		23,398 (21.9)	**20,092 (21.0)**	**3,306 (29.5)**	
College or higher	362,930 (36.2)	**304,672 (38.0)**	**58,258 (29.1)**		46,682 (43.6)	**42,810 (44.7)**	**3,872 (34.5)**	
Unknown	141,630 (14.1)	**118,843 (14.8)**	**22,787 (11.4)**		36,899 (34.5)	**32,855 (34.3)**	**4,044 (36.0)**	
Economic level				**< 0.001**				**< 0.001**
High	76,058 (7.6)	**62,503 (7.8)**	**13,555 (6.8)**		11,605 (10.8)	**10,495 (11.0)**	**1,110 (9.9)**	
Middle-high	261,374 (26.1)	**214,992 (26.8)**	**46,382 (23.1)**		30,385 (28.4)	**27,529 (28.7)**	**2,856 (25.5)**	
Middle	471,065 (47.0)	**380,696 (47.4)**	**90,369 (45.1)**		52,176 (48.8)	**46,897 (49.0)**	**5,279 (47.0)**	
Middle-low	152,438 (15.2)	**115,306 (14.4)**	**37,132 (18.5)**		10,614 (9.9)	**9,068 (9.5)**	**1,546 (13.8)**	
Low	41,862 (4.2)	**28,843 (3.6)**	**13,019 (6.5)**		2,199 (2.1)	**1,768 (1.8)**	**431 (3.8)**	
School performance				**< 0.001**				**< 0.001**
High	122,271 (12.1)	**104,110 (13.0)**	**18,161 (9.1)**		13,455 (12.6)	**12,434 (13.0)**	**1,021 (9.1)**	
Middle-high	255,035 (25.4)	**213,181 (26.6)**	**41,854 (20.9)**		26,422 (24.7)	**24,330 (25.4)**	**2,092 (18.6)**	
Middle	284,082 (28.3)	**229,696 (28.6)**	**54,386 (27.1)**		32,771 (30.6)	**29,690 (31.0)**	**3,081 (27.5)**	
Middle-low	235,662 (23.5)	**181,468 (22.6)**	**54,194 (27.0)**		23,949 (22.4)	**20,875 (21.8)**	**3,074 (27.4)**	
Low	105,747 (10.5)	**73,885 (9.2)**	**31,862 (15.9)**		10,382 (9.7)	**8,428 (8.8)**	**1,954 (17.4)**	

Note. Values are expressed as a number (%) and mean ± SD. The *P* value was used for the chi-square tests for categorical variables and the *t*-test was used for continuous variables. Numbers in bold indicate a significant difference ($P < 0.05$). BMI, body mass index; SD, standard deviation.

Table 2. Baseline characteristics for substance use* among Korean youth in KYRBS, 2005–2021

Variables	Pre-COVID-19 pandemic				COVID-19 pandemic			
	Overall (*n* = 936,729), *n* (%) or mean ± SD	No (*n* = 927,170), *n* (%) or mean ± SD	Yes (*n* = 9,559), *n* (%) or mean ± SD	*P* value	Overall (*n* = 106,979), *n* (%) or mean ± SD	No (*n* =106.256), *n* (%) or mean ± SD	Yes (*n* = 723), *n* (%) or mean ± SD	*P* value
Age, years	14.98 ± 1.74	**14.98 ± 1.74**	**14.87 ± 1.77**	**< 0.001**	15.09 ± 1.75	**15.09 ± 1.75**	**15.34 ± 1.73**	**< 0.001**
Grade				**< 0.001**				**< 0.001**
7^{th}–9^{th} grade (middle school)	482,947 (51.6)	**477,720 (51.5)**	**5,227 (54.7)**		57,611 (53.9)	**57,286 (53.9)**	**325 (45.0)**	
10^{th}–12^{th} grade (high school)	453,782 (48.4)	**449,450 (48.5)**	**4,332 (45.3)**		49,368 (46.1)	**48,970 (46.1)**	**398 (55.0)**	
Sex				**< 0.001**				**0.001**
Male	482,443 (51.5)	**476,345 (51.4)**	**6,098 (63.8)**		55,460 (51.8)	**55,040 (51.8)**	**420 (58.1)**	
Female	454,286 (48.5)	**450,825 (48.6)**	**3,461 (36.2)**		51,519 (48.2)	**51,216 (48.2)**	**303 (41.9)**	
BMI, kg/m^2	20.73 ± 3.14	**20.72 ± 3.13**	**20.62 ± 3.21**	**0.001**	21.57 ± 3.75	**21.57 ± 3.75**	**22.07 ± 4.00**	**< 0.001**
Residence				**0.010**				**0.001**
Rural	438,806 (46.8)	**434,453 (46.9)**	**4,353 (45.5)**		46,398 (43.4)	**46,107 (43.4)**	**291 (40.2)**	
Urban	497,923 (53.2)	**492,717 (53.1)**	**5,206 (54.5)**		60,581 (56.6)	**60,149 (56.6)**	**432 (59.8)**	
Currently smoking	94,390 (10.1)	**91,003 (9.8)**	**3,387 (35.4)**	**< 0.001**	4,624 (4.3)	**4,529 (4.3)**	**95 (13.1)**	**< 0.001**
Alcohol use	189,915 (20.3)	**185,705 (20.0)**	**4,210 (44.0)**	**< 0.001**	11,222 (10.5)	**11,041 (10.4)**	**181 (25.0)**	**< 0.001**
Depression	304,574 (32.5)	**299,265 (32.3)**	**5,309 (55.5)**	**< 0.001**	27,622 (25.8)	**27,226 (25.6)**	**396 (54.8)**	**< 0.001**
Highest educational level of parents				**< 0.001**				0.438
High school or lower	471,742 (50.4)	**467,345 (50.4)**	**4,397 (46.0)**		23,398 (21.9)	23,253 (21.9)	145 (20.1)	
College or higher	333,042 (35.6)	**329,854 (35.6)**	**3,188 (33.4)**		46,682 (43.6)	46,365 (43.6)	317 (43.8)	
Unknown	131,945 (14.1)	**129,971 (14.0)**	**1,974 (20.7)**		36,899 (34.5)	36,638 (34.5)	261 (36.1)	
Economic level				**< 0.001**				**< 0.001**
High	70,123 (7.5)	**68,786 (7.4)**	**1,337 (14.0)**		11,605 (10.8)	**11,510 (10.8)**	**95 (13.1)**	
Middle-high	243,448 (26.0)	**241,305 (26.0)**	**2,143 (22.4)**		30,385 (28.4)	**30,201 (28.4)**	**184 (25.4)**	
Middle	439,851 (47.0)	**436,348 (47.1)**	**3,503 (36.6)**		52,176 (48.8)	**51,878 (48.8)**	**298 (41.2)**	
Middle-low	143,458 (15.3)	**141,912 (15.3)**	**1,546 (16.2)**		10,614 (9.9)	**10,511 (9.9)**	**103 (14.2)**	
Low	39,849 (4.3)	**38,819 (4.2)**	**1,030 (10.8)**		2,199 (2.1)	**2,156(2.0)**	**43 (5.9)**	
School performance				**< 0.001**				**< 0.001**
High	113,977 (12.2)	**112,645 (12.1)**	**1,332 (13.9)**		13,455 (12.6)	**13,349 (12.6)**	**106 (14.7)**	
Middle-high	238,300 (25.4)	**236,596 (25.5)**	**1,704 (17.8)**		26,422 (24.7)	**26,259 (24.7)**	**163 (22.5)**	
Middle	265,536 (28.3)	**263,195 (28.4)**	**2,341 (24.5)**		32,771 (30.6)	**32,586 (30.7)**	**185 (25.6)**	
Middle-low	220,157 (23.5)	**217,805 (23.5)**	**2,352 (24.6)**		23,949 (22.4)	**23,779 (22.4)**	**170 (23.5)**	
Low	98,759 (10.5)	**96,929 (10.5)**	**1,830 (19.1)**		10,382 (9.7)	**10,283 (9.7)**	**99 (13.7)**	

Note. *Substance use data for 2015 were excluded (total *n* = 1,043,708). Values are expressed as a number (%) and mean ± standard deviation. The *P* value was used for the chi-square tests for categorical variables and the *t*-test was used for continuous variables. Numbers in bold indicate a significant difference ($P < 0.05$). BMI, body mass index; SD, standard deviation.

school or lower education level, and those who demonstrated lower academic performance, were more susceptible to alcohol consumption, both before and during the pandemic. Compared to the pre-pandemic period, during the pandemic period, being male was associated with a higher risk of

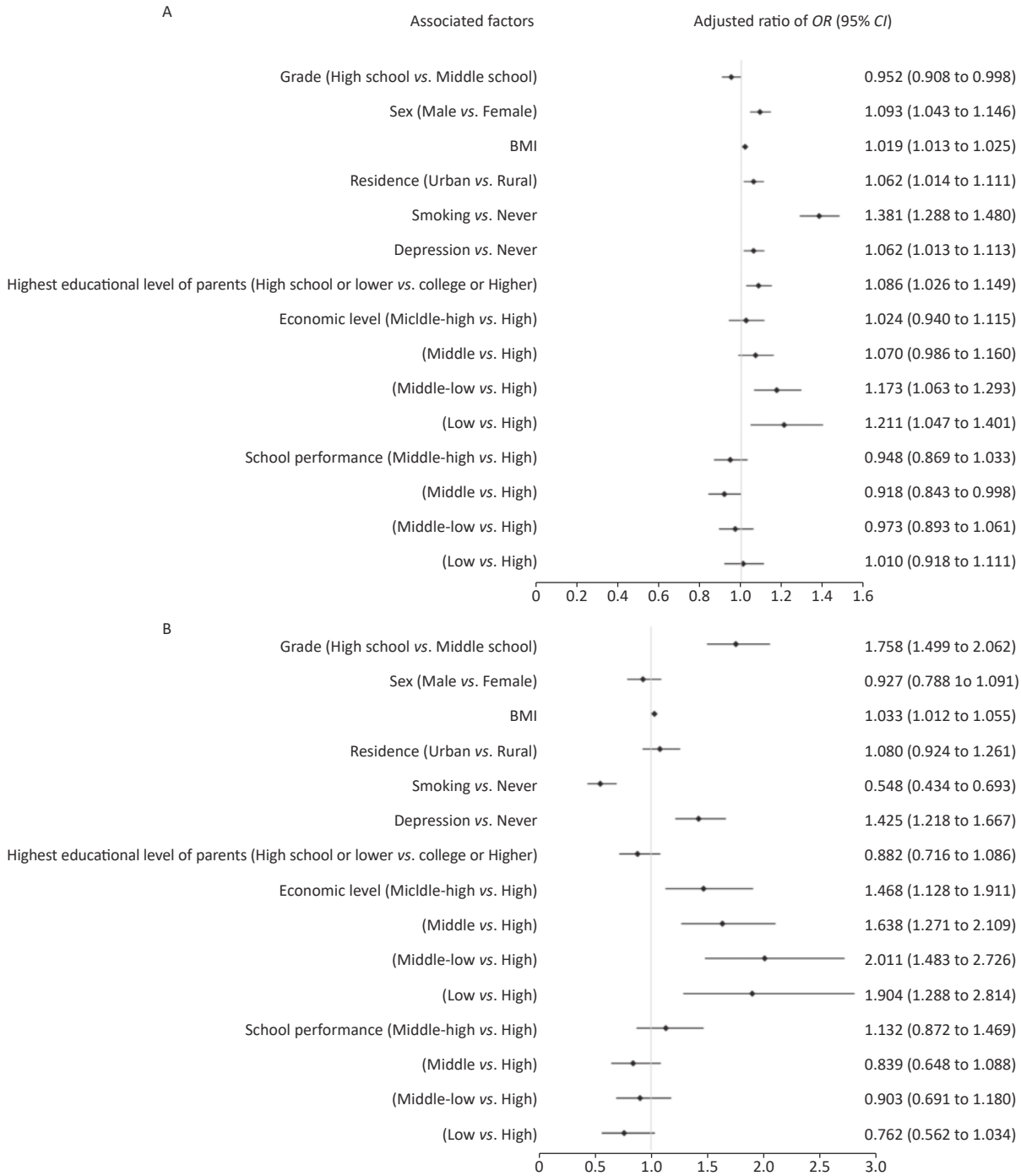

Figure 1. Pre-to-during pandemic ratio of odds ratios for the associations. (B) Association between associated factors and alcohol use. (B) Association between associated factors and substance use. Horizontal lines indicate corresponding 95% confidence intervals around ratio of odds ratios. Ratio of odds ratios was calculated as $OR_{\text{during-pandemic}}$ divided by $OR_{\text{pre-pandemic}}$ (ROR = $OR_{\text{during-pandemic}}$/ $OR_{\text{pre-pandemic}}$). BMI, body mass index; *CI*, confidence interval; *OR*, odds ratios; *ROR*, ratio of odds ratio.

alcohol use (*ROR*, 1.093; 95% *CI*, 1.043–1.146), as well as increased BMI (*ROR*, 1.019; 95% *CI*, 1.013–1.025), urban residence (*ROR*, 1.062; 95% *CI*, 1.014–1.111), low educational level of parents (*ROR*, 1.086; 95% *CI*, 1.026–1.149), and low economic level (*ROR*, 1.211; 95% *CI*, 1.047–1.401). Additionally, during the pandemic period, currently smoking (*ROR*, 1.381; 95% *CI*, 1.288–1.480) and depression (*ROR*, 1.062; 95% *CI*, 1.013–1.113) were associated with a higher risk of alcohol use than during the pre-pandemic period (Figure 1A).

For both the pre-pandemic and pandemic periods, male sex, current smoking, alcohol use, and depression were associated with an increased risk of substance use. Compared with the pre-pandemic period, during the pandemic period, high school students (*ROR*, 1.758; 95% *CI*, 1.499–2.062), increased BMI (*ROR*, 1.033; 95% *CI*, 1.012–1.055), and depression (*ROR*, 1.425; 95% *CI*, 1.218–1.667) had a higher risk of substance use. Current smoking (*ROR*, 0.548; 95% *CI*, 0.434–0.693) was associated with a lower risk of substance use during the pandemic than during the pre-pandemic period (Figure 1B).

To the best of our knowledge, this is the first nationwide, large-scale study using a representative population-based dataset to examine the familial-, social-, and individual-associated risk factors related to changes/an increase in alcohol and substance use before and during the pandemic in over 1 million Korean adolescents. Specifically, the factors associated with the risk of both alcohol and substance use during the pandemic were male sex, current smoking status, alcohol consumption, and depression.

Overall, certain risk factors were consistently associated with increased alcohol and substance use among Korean adolescents, including male sex, lower school grades, current smoking, depression, as well as certain socioeconomic factors such as a lower educational level of parents and a lower economic level. During the COVID-19 pandemic, an increase in BMI and urban residence were notable additional factors associated with increased alcohol use, whereas non-current smoking was associated with increased substance use. Additionally, lower economic status was found to have a greater impact on substance use during the pandemic than during the pre-pandemic period.

Adolescents who used substances smoked 2–4 times more than those who did not smoke[9]. In our study, not currently smoking was correlated with higher substance use. Previous studies have found that current smokers are twice as likely to develop severe or critical COVID-19 symptoms as those who have never smoked or quit smoking[10]. The decrease in the number of current smokers may be due to concerns about the risk of COVID-19, along with more motivated social circumstances and easier cessation processes[2,10]. However, those trying to quit smoking may relapse to other substance use, and their depression and other debilitating effects may recur.

Utilizing nationwide large-scale data from over 1 million adolescents, the outcomes of this study suggest a complex interaction between a multitude of factors influencing adolescent alcohol and substance use. Increased BMI, depression, and lower economic status were more pronounced and significant in adolescents with alcohol and substance use (vulnerable populations).

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